



ESTEEM

Academic Journal UiTM Pulau Pinang

Volume 5, Number 1

June 2009

ISSN 1675-7939

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Soffian Noor Mat Saliah
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Esteem Academic Journal is jointly published by the Universiti Teknologi MARA, Pulau Pinang and University Publication Centre (UPENA), Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia.

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Volume 5, Number 1

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ISSN 1675-7939

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Foreword

Alhamdulillah. First of all a big thank you and congratulations to the Editorial Board of *Esteem Academic Journal* of Universiti Teknologi MARA (UiTM), Pulau Pinang for their diligent work in producing this issue. I also would like to thank the academicians for their contributions and the reviewers for their meticulous vetting of the manuscripts. A special thanks to University Publication Centre (UPENA) of UiTM for giving us this precious opportunity to publish this first issue of volume 5. In this engineering issue we have upgraded the standard of the manuscript reviewing process by inviting more reviewers from our university as well as other universities in Malaysia. We have embarked from previous volume to establish a firm benchmark and create a journal of quality and this current issue remarks a new height of the journal quality. Instead of publishing once in every two years, now *Esteem* publishes two issues annually.

In this issue, we have compiled an array of 13 interesting engineering research and technical based articles for your reading. The first article is entitled “The Response of Tube Splitting on Circular Tubes by Using Various Types of Semi-angles Dies and Slits”. The authors, Mohd Rozaiman Aziz and Roslan Ahmad investigated the axial splitting and curling behavior of aluminum circular metal tubes which was compressed axially under static loading using three types of dies with different semi-angles. The authors concluded that the introduction of slit to the specimen is necessary to initiate slitting rather than inversion.

Salina Budin, Aznifa Mahyam Zaharudin, and Sugeng Priyanto presents a model of energy conversion and impact energy generation during collision based on free falling experiment, which is closely resembles direct collision between ball and inner wall of the vial. Simulation results from the proposed impact energy model demonstrated that the impact energy generated during the collision is strongly influenced by the thickness of the work materials and reaches zero at certain value of the work materials thickness, which increases with an increase of falling height.

Salina Alias, Caroline Marajan and Mohamad Azrul Jemain wrote an article that looks at adsorption of zinc from waste water using bladderwort (*Utricularia vulgaris*). In batch adsorption studies, data show that dried bladderwort has considerable potential in the removal of metal ions from aqueous solution. The fourth article written by

Muhammad Khusairi Osman et al. looked at 3D object recognition using affine moment invariants and Multiple Adaptive Network Based Fuzzy Inference System (MANFIS). The experimental results show that Affine Moment Invariants combined with MANFIS network attain the best performance in both recognitions, polyhedral and free-form objects.

The article entitled “Construction Waste Management Methods Used by Contractors in the Northern Region” authored by Siti Hafizan Hassan, Nadira Ahzahar and Mohd Nasrul Nizam Nasri reports an ongoing study on the use of construction waste management methods by contractors and its impact on waste reduction in the Northern Region. In conclusion, the sizing and amount of materials to be ordered to reduce wastage is significant in reducing construction waste generation waste, alleviating the burden associated with its management and disposal. The sixth article by Muhammad Sofian Abdullah et al. examined on the performance of Performance of Palm Oil Fuel Ash (POFA) with lime as stabilizing agent for soil improvement. The authors concluded that POFA can be used to treat the silty soil as well as to reduce the environmental problem.

The seventh article penned by Soffian Noor Mat Saliah, Noorsuhada Md. Nor and Megat Azmi Megat Johari presents the results of an experimental study on the interfacial bond strength (IBS) of polypropylene fiber concrete (PFC). It was found that the interfacial bond strength between concrete and reinforcement bar was not affected by the inclusion of polypropylene fibers. However, concrete containing fibers exhibited no breaking of concrete and no debonding of reinforcement. The article by Juliana Zaabar and Rusnani measures, evaluates and analyzes the network link performance of fiber optic cable using OTDR. The authors suggested that the major loss for these measurements is connector loss. Preventive maintenance will increase the life time of fiber optic. From some of the findings, the PVC dust cap has been identified as a main source of contamination for the SC connector.

The article entitled “Symbolic Programming of Finite Element Equation Solving for Plane Truss Problem” by Syahrul Fithry Senin proposed a plane truss problem to be solved by finite element method using MAPLE 12 software. The numerical solution computed by the author was almost matched with the commercial finite element software solution, LUSAS. The tenth article by Nor Azlan Othman, Nor Salwa Damanhuri and Visakan Kadirkamanathan presents a detail review of fault diagnosis in rotating machinery using pattern recognition technique. The authors proposed a solution based on artificial neural network (ANNs) which is Multi-Layer Perceptron (MLP). The authors concluded that

the proposed methods are suitable for rotating machinery on fault detection and diagnosis.

The eleventh article is entitled “RAS Index as a Tool to Predict Sinkhole Failures in Limestone Formation Areas in Malaysia”. Damanhuri Jamalludin et al. found that, using the RAS classification method, the prediction of sinkhole occurrences can be easily be made by simply knowing the weekly rainfall especially in areas having limestone as the bedrock. The twelfth by Muhammad Hafeez Osman et al. explores cases regarding the histories of rock slope repair and stabilization of unstable boulder along the road from Bukit Cincin to Genting Highland and along the road from Gap to Fraser Hill. The last article is “Soil Nail and Guniting Works in Pahang”. The authors, Damanhuri Jamalludin et al. concluded that if the stability of the embankment needs to be improved, soil nails can be installed and embankment surface can be covered with gunite to prevent erosion.

We do hope that you not only have an enjoyable time reading the articles but would also find them useful. Thank you.

Mohd Aminudin Murad
Chief Editor
Esteem, Vol. 5, No. 1, 2009
(Engineering)

Adsorption of Zinc from Waste Water Using Bladderwort (*Utricularia vulgaris*)

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ABSTRACT

*Environmental issues in Malaysia such as water pollution have increased rapidly due to the country's development and its movement towards globalization. Amongst these developments are the expansions of industrial and manufacturing sectors in the country. Several of these industrial sectors have discharged heavy metals to open rivers. As such, surface water sources are being depleted and limited due to polluted rivers and thus cannot be used for water consumption. Despite advanced pollution control techniques, heavy metals still could find their ways particularly through waste water discharge or leachate of solid waste. Hence, with increasing environmental awareness and government policies, it has become necessary to develop new environmental friendly techniques to reduce the contaminants using low cost methods and materials. The main techniques developed to remove heavy metals from water include chemical precipitation, membrane filtration, ion exchange and adsorption. In this research, Bladderwort (*Utricularia vulgaris*) is introduced as an adsorbent material for zinc (Zn). Bladderwort is an aquatic lake plant found to be cost effective and economical as it can be found in most lakes. For the purpose of this study, Bladderwort was collected from paddy field (*Oryza sativa* L.) around Permatang Pauh, Pulau Pinang. The aquatic plant collected must be treated before it undergoes sieve analysis in order to get the different size of Bladderwort. The batch studies were conducted to*

determine the factors affecting adsorption such as the size, pH and agitation speed. The results indicated that zinc removal is efficient at pH 7 and at the size of 150 mm. It is found that the agitation speed also influences the adsorption process with maximum zinc removal of 97.5% occurring at 200 r.p.m. This research indicates that Bladderwort could become one of the natural adsorbents in managing zinc problems from waste water.

Keywords: *Bladderwort, water pollution, waste water, adsorption*

Introduction

Water pollution is a serious problem, and heavy metals are common pollutants in water that threaten human health and environmental quality. Water containing heavy metals pollutants may come from different industrial activities such as mining, steel and textile industries, automotive, metal finishing, electroplating, battery manufacturing, electric cable manufacturing, tannery and power plants (Saygideger, Gulnaz, Istifli & Yucel, 2005). Methods of minimizing heavy metal concentrations in surface waters and wastewaters are therefore crucial for environmental protection.

The removal of toxic metals such as chromium, mercury, lead, copper and cadmium from wastewater is a matter of great interest in the field of water pollution. Toxic metals even in small quantities, is a serious cause of water degradation and is particularly hazardous to organism since they remain in food chain (Peavy, Rowe & Tchobanoglous, 1985). However, the existence of nontoxic metals such zinc and copper when both are present in natural water may be toxic to many biological species (Peavy et al., 1985). Thus, all heavy metals can be said as toxic and non-biodegradable and should be separated from water (Shafaei, Ashtiani & Kaghazchi, 2005).

These facts have motivated many physicochemical methods for heavy metal removal from aqueous solution, including adsorption, chemical precipitation and solvent extraction, reverse osmosis, ion exchange, chemical oxidation and reduction, filtration, and electrochemical treatment (Senthilkumar, Vijayaraghavan, Thilakavathi, Iyer & Velan, 2005; Park, Yun & Lee, 2006; El-Sikaily, Nemr, Khaled & Abdelwehab, 2006). Among the various water-treatment techniques described, adsorption is generally preferred for the removal of heavy metal ions due to its high efficiency, easy handling, availability of different adsorbents and cost effectiveness (Shafaei et al., 2005; Senthilkumar et al., 2005).

Among current adsorbents, activated carbon is the most widely used adsorbent material in different industries. However, it is not a selective adsorbent because it is expensive for required regeneration and may be lost in application processes. Recently, a number of studies were carried out on low cost adsorbents from natural resources. The use of low cost natural adsorbents derived from natural resources for heavy metals removal that has been reviewed are *Lemna minor* (Horvat, Vidaković-Cifrek, Oreščanin, Tkalec & Kozlina, 2007), seaweeds (Senthilkumar et al., 2005; Park et al., 2006) and marine alga (Kumar, King & Prasad, 2006; El-Sikaily et al., 2006) for the removal of heavy metal from wastewater.

Floating plants such as *Lemna minor* offers promising results with regard to metal removal from wastewater (Oporto, Arce, Broeck, Bruggen & Vandecasteele, 2006; Horvat et al., 2007; Nicholas, Steven & Kathryn, 2003; Drost, Matzke & Backhaus, 2007). As submerged plants completely inundated and have the ability to take up metals directly from the water, they are suggested as useful species in reducing metal concentrations in stormwater (Fritioff, Kautsky & Greger, 2005) and secondarily treated wastewaters (Keskinan, Goksu, Yuceer, Basibuyuk & Forster, 2003). Submerged rooted plants extract metals from the sediment via their root systems and directly from the surrounding water via their shoot. Generally, the uptake process of metals in aquatic plants contains two steps: (i) an initial fast, reversible metal-binding step involving physico-chemical processes such as chelation, ion exchange, precipitation and adsorption, and (ii) a slow, irreversible ion-sequestration step consisting of biological processes such as intracellular uptake, vacuolar deposition and translocation (Salt et al., 1995). Keskinan et al. (2003) referred both processes as biosorption and bioaccumulation.

However, to date, there is very scarce research about heavy metal uptake by Bladderwort (*Utricularia vulgaris*), another species of floating aquatic plant. Bladderworts are unusual and highly specialized plants. They have no roots and their simple structure makes distinguishing between leaf, shoot, and stem seem arbitrary. The bladder traps, conversely, are recognized as one of the most sophisticated structures in the plant kingdom. The Bladderworts structure is shown in Figure 1.

In this research, adsorption ability of Bladderwort was investigated for removal of Zn ions from simulated wastewater. The factors that affect biosorption capacity, such as pH, the dosage of biosorbent, the initial Zn concentration, surface area and agitation speed were examined by batch study. Batch adsorption studies consist of employing the

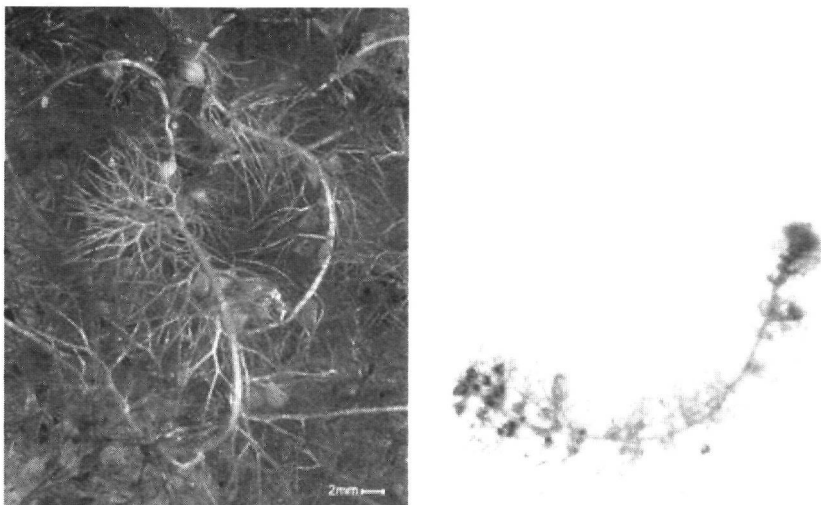


Figure 1: Structure of the Common Bladderwort (*Utricularia vulgaris*)

adsorbent, influent in certain solution condition such as pH and temperature before mixing all of it by shaking (Shafaei et al., 2005; Senthilkumar et al., 2005; Park et al., 2006; El-Sikaily et al., 2006).

Materials and Method

Bladderwort Preparation

Bladderwort (*Utricularia vulgaris*) was collected from paddy field around Permatang Pauh, Pulau Pinang. After transporting back to the laboratory, the seaweeds were first washed thoroughly with distilled water and oven dried at 80°C overnight as shown in Figures 2 and 3. The dried Bladderwort was blended in a homogenizer into finer particles. Sizes of Bladderwort ranging from 2000 μm to 0.063 μm were obtained by passing through stainless steel standard sieves.

Batch Adsorption Studies

The ion exchange of heavy metals on dried Bladderwort was carried out using the batch method. Batch adsorption experiments were conducted using 5 g of adsorbent with 100 mL of solutions containing heavy metal

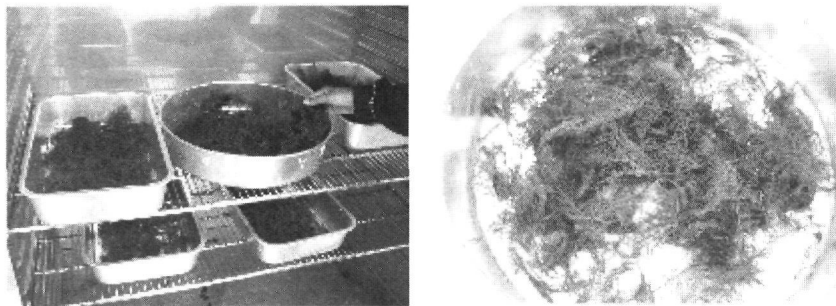


Figure 2: Bladderwort was Washed One by One to Ensure All Impurities were Removed

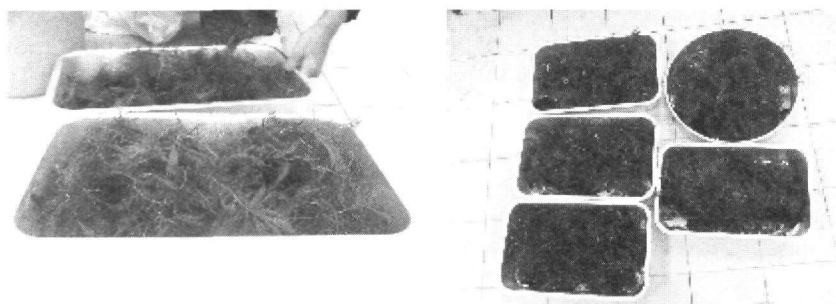


Figure 3: Bladderwort Structure After Been Dried for 24 Hours to Remove the Water Content

ions of desired concentrations at room temperature in 250 mL conical flask. The Bladderwort size used was in the range of 600 to 150 μm . The suspensions were shaken using Orbital Shaker model 719 at agitation speed (200 r.p.m) with pH adjustment at pH 1, 3, 5, 7, 9, 11, and 13 for 1 hour to reach the equilibrium as shown in Figure 4.

The pH of solutions was adjusted by dilute H_2SO_4 or NaOH at the beginning of the experiment and was not controlled afterwards and it was measured by using Benchtop pH/Mv/Temperature. After 1 hour of agitation speed, the suspensions were let to settle for 30 minutes as shown in Figure 5.

The solution containing heavy metal was separated from the biomass by filtration through Whatman filter paper (No. 42). The exact concentration of metal ions and filterable metal concentrations were determined by DR/2400 Spectrometer.

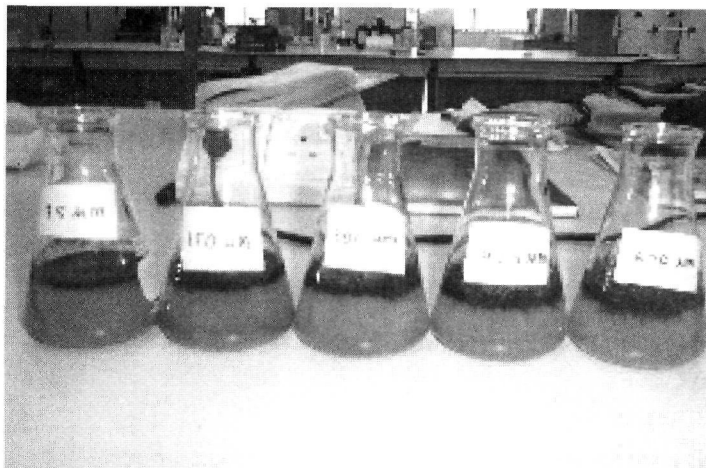


Figure 4: The Solution with Appropriate pH was Filled into the Flask

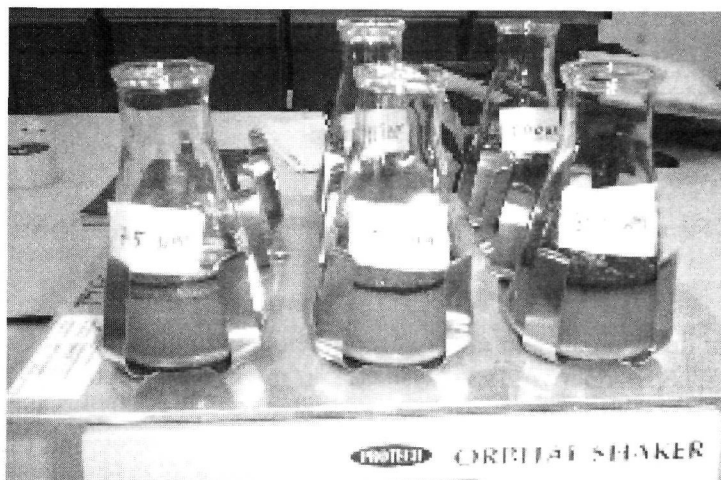


Figure 5: All the Flasks were Shaken Using Orbital Shaker for 1 Hour of Contact Time and Another 1 Hour for Retention Time at Certain R.P.M to Studies on The Effect of Rotation Speed

The adsorption efficiency, A%, of the metal ion was calculated using the following equation:

$$\% \text{ Adsorption efficiency } (\%A) = \frac{C_i - C_f}{C_i} \times 100 \quad (1)$$

where C_i and C_f are the concentrations of the metal ion in initial and final solutions respectively.

Results and Discussion

Effect of Different pH of Bladderwort

It is well known that the pH of the medium affects the solubility of metal ions and the concentration of the counter ions on the functional groups of the biomass cell walls. Therefore, pH is an important parameter on biosorption of metal ions from aqueous solutions.

As shown in Figure 6, the adsorption of the Zn increased with the increase in pH from 2.0 to 5.0 and then decreased with increasing pH from 9.0 to 12.0. The lowest metal uptake values were determined at pH 1.0. According to Saygideger et al. (2005), at lower pH more protons will be available to protonate active groups of biomass surface, such as chitin, acidic polysaccharides, lipids, amino acids and other cellular components of the micro organism and metal ions are competing with the H^+ in the solution at low pH values for adsorption. Ghimire, Inoue, Ohto and Hayashida (2007) suggested that metal ions are adsorbed according to a cation exchange mechanism, releasing protons from the carboxyl analog of alginic acid contained in the gel. This is further supported by the fact that the pH of the aqueous solution had been decreased after the adsorption of metal ions.

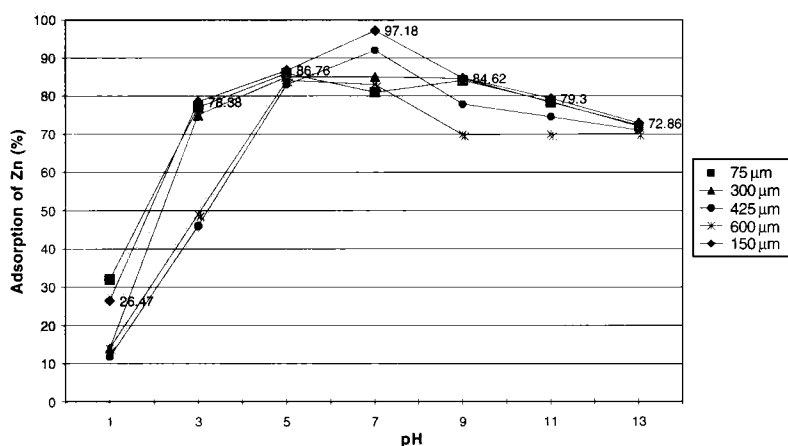


Figure 6: Effect of pH on Adsorption Zn onto Bladderwort

As the pH increased, there was an increase in the negative charge density on the Bladderwort surface, increasing the attraction of metallic ions with positive charge and allowing biosorption onto the cell surface. Above pH 7, insoluble zinc hydroxide starts precipitating from the solution, so that adsorption rate was decreased.

In this study, these zinc cations at around pH 7 would be expected to interact more strongly with the negatively charged binding sites in the adsorbent. As a result, the optimum pH for zinc adsorption was found as 7 and the other adsorption experiments were performed at this pH value (Kumar et al., 2006, Amarasinghe & Williams, 2007).

Effect of Different Size of Bladderwort

Surface area of the adsorbent is an important parameter for adsorption. Exposure of adsorbent sites for solid-metal ion interaction is high if the surface area of adsorbent is high. The smaller the particle size, the higher the surface area per unit weight of adsorbent and hence higher percentage of metal removal is expected (Amarasinghe & Williams, 2007).

The effect of particle sizes of adsorbent on the adsorption of zinc at different pH is presented in Figure 7. It was found that the adsorption is less dependent on Bladderwort size ranging from 150-600 μm . However, Bladderwort size of 150 μm produced a higher adsorption compared to other sizes at pH 7. Furthermore, it is observed clearly at pH 1 that the percentage of adsorption decreases with the increasing geometric mean of adsorbent size. This is because, adsorption being a surface phenomenon, the smaller particle sizes offered comparatively larger surface area and hence higher adsorption occurs at equilibrium (Jain, Singhalb & Sharmaa, 2004; Kumar et al., 2006; Kandah, 2001).

Effects of Different Agitation Speed

The effect of shaker rotation speed (50-250 r.p.m) on adsorption by Bladderwort was studied. Optimal value of adsorption capacity is obtained at the stirring speed of 200 r.p.m as shown in Figure 8.

The adsorption efficiency increased with the increase of agitation speed up to 200 r.p.m. Besides, the result indicates that the adsorption of zinc ions was faster at higher agitation speeds than at lower ones. When the agitation speed is increased, the diffusion rate of metal ions from the bulk liquid to the liquid boundary layer surrounding particles became higher because of the enhancement of turbulence and a decrease of the

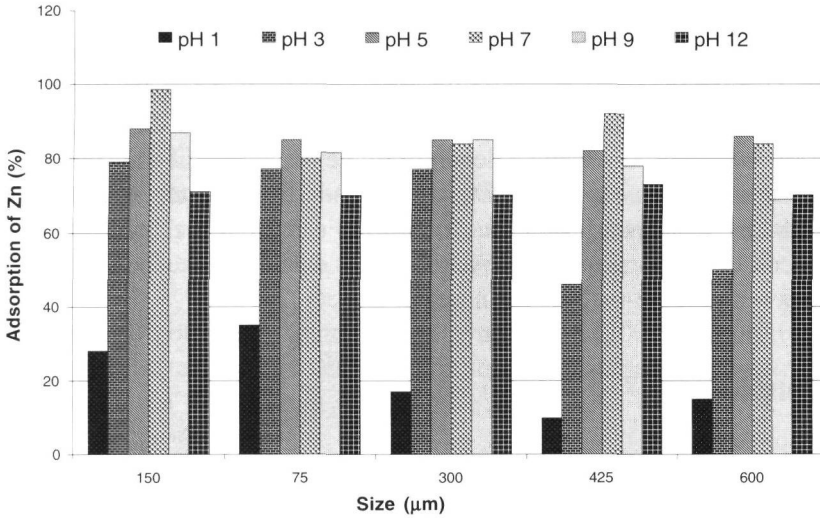


Figure 7: Effect of Different Sizes of Bladderwort on Adsorption Zn

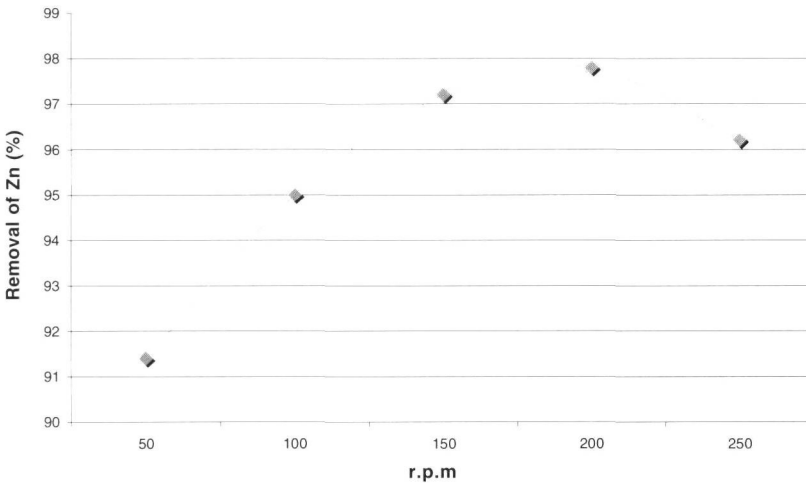


Figure 8: Zinc Percentage of Removal at Different Agitation (Rotation) Speed

thickness of the liquid boundary layer. Under these conditions, the value of the external diffusion coefficient became larger (Shen & Duvnjak, 2005).

It is obvious that agitation helps zinc ion removal from aqueous solutions. This is because Zn ions, through their transportation to the solid phase, meet resistance at the liquid phase, through the boundary layer. Agitation of suspensions during experiments has led to a decrease of the boundary layer and a decrease to the resistance of transportation of zinc ions. This increases the transfer rate of the ions and the adsorption of the minerals (Inglezakis et al., 2007). Furthermore at lower stirring speeds, the agglomeration recovery was low due to the insufficient contact between particle-particle (Sönmez & Cebeci, 2003).

Conclusion

In batch adsorption studies, data show that dried Bladderwort has considerable potential in the removal of metal ions from aqueous solution. Adsorption capacity of Zn by Bladderwort is pH dependent and increase a little with alkali condition but decreased in acidic condition according to a cation exchange mechanism. However, it can be said that most metal ions are adsorbed to the extent of 80-100% at weakly acidic conditions.

The performance of Bladderwort is due to its properties. Bladderwort with higher surface area will be a more efficient adsorbent compared one of lower surface area. However, in the experiment conducted, surface area of bladderwort is less dependent on adsorption capacity of Zn. The effect of agitation speed on the adsorption system was also discussed. It was clear that the adsorption efficiency of metal ions is influenced by mixing rate. The optimum agitation speed of batch study using Bladderwort was found at 200 r.p.m and thus it can be an effective candidate for tackling Zn pollutions.

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